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Project title: Development of novel numerical methods for analysing metal forming of high-strength steels.

Abstract

Material processing techniques, such as drawing and rolling, are used to manufacture metal rods and wires, which could be used, for example, as a reinforcement for pipes on the seabed. However, in order to produce high-strength wires or rods, the metal has to go through a series of deformation passes, with each step specifically designed. The drawback of such techniques is that it is not possible to predict the shape, size and properties of the final workpiece until the end of the processing route. Furthermore, each of these iterations might even take weeks or months to complete.

Therefore, metallurgists and engineers frequently incur into this enormous optimisation problem and they might attempt to modify the tool design for three or four passes based on previous experience. However, this approach is slow and expensive.

One of the most promising ways to solve this problem is to create a roller design tool using finite element or finite volume methods. These methods could accelerate the material processing route reducing the number of physical iterations, and hence reducing the cost of the industrial process. They could even predict final properties of complicated 3D geometries.

The finite element method has already been extensively used by multiple modelling software, such as DEFORM® or Autodesk Forge, to predict the outcome of a certain processing route, but there might be a few potential benefits in using the finite volume method. One benefit worth mentioning is the local conservativeness of the finite volume method, which might not matter if the problem consists of many elements, but it might make a difference for coarser meshes. However, both methods struggle when dealing with the problem of incompressibility for plastic deformation. This incompressibility constraint sets a numerical challenge for the project, while attempting to implement novel numerical methods that might have advantages over the current state-of-the-art finite element methods.